

part, take the form of transverse folds and lateral loops. In the middle region these are confined to the space between the vitelline glands, but more posteriorly they sometimes extend laterally beyond the intestinal diverticula. The ascending limb of the uterus passes forward between, and ventrally to, the testes. The eggs are roundish-oval in shape, and when fully formed have a rather thick brown shell, usually showing an indentation on one side, so that in profile one side is convex, the other concave. The eggs measure $42.5-50 \mu \times 30-35 \mu$.

The variety described above I propose to call

Dicrocoelium lanceatum St. & Hass., var. *symmetricum*,

in allusion to the arrangement of the testes.

This variety being at present known only from specimens collected from a single host, a cat, it is doubtful whether it should be regarded as a "local" variety or as a form peculiar to cats. An examination of examples of *D. lanceatum* from sheep or other herbivorous animals in the same locality would be of great interest from this point of view, as well as a further investigation of the parasites of cats. In any case, it would appear that the older helminthologists may have been correct in reckoning the cat among the hosts of "*Distomum lanceolatum*."

EXPLANATION OF PLATE XIV.

Dicrocoelium lanceatum, var. *symmetricum*. Ventral view of a stained specimen. *C.S.*, cirrus-sac; *Int.*, intestinal diverticulum; *Or.*, ovary; *R.*, receptaculum seminis; *T.*, left testis; *V.*, vitelline glands; *V.S.*, ventral sucker.

VII. — *The Eggs and Spawning-habits of the Pilot Fish* (*Naucrates ductor*). By J. D. F. GILCHRIST, M.A., D.Sc., Ph.D.

IN the course of a general enquiry into the spawning-habits of Cape fishes, a mature female of the pilot fish was found. The eggs and larvæ of about thirty Cape fishes have been described in local publications, but, as the pilot and its peculiar habits are so well known, and have attracted attention in all parts of the world, a description of the mature eggs of this fish, hitherto unrecorded, may be worthy of a special note, and interest a wider circle of readers, more especially as the nature of the eggs seems to

throw light on some peculiarities in the behaviour of the fish.

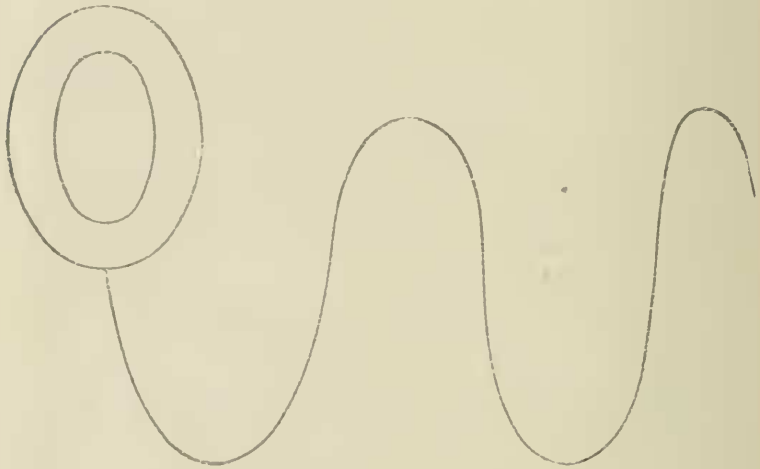
The pilot fish is not uncommon in the Cape seas. The young are frequently abundant in the summer months, being found in company with the young of *Lichia amia*, which they somewhat resemble in the characteristic markings of the body. The adults are well known, under the name "Lootsman," to Cape fishermen, who state that they are always found accompanying a large shark, called the "Tornijn Haai" or porpoise-shark (*Charcharias melanopterus*). They take up a more or less constant position near the body of the shark, and remain within a few inches of the base of the pectoral fin. The fishermen have also noted that they have the habit of darting away from the shark towards any strange object, and then returning to their former position. This well-known behaviour, interpreted in other parts of the world as a guiding or piloting of the shark to its food, the Cape fishermen believe, is for the purpose of a preliminary tasting or testing of the food on behalf of the shark.

On one occasion, in the month of December, a specially large pilot fish was caught on the hook by some fishermen fishing off Cape Point. It was in the company of a porpoise-shark. By placing the fish in a bucket of water, it was possible to keep it alive, and convey it to the Marine Laboratory at St. James, where it was placed in a large tank, and seemed none the worse for its capture. It proved to be a mature female with ripe eggs, which were extruded on slight pressure.

These extruded eggs were readily seen, being large, though quite transparent. When placed in water, however, they became almost invisible. They did not float, and they adhered to each other and to objects with which they came in contact. The shape of the eggs was distinctly oval, though a few were more rounded. A typical example, shown in the accompanying figure (p. 116), measured 1.74 mm. in length and 1.3 mm. in greatest breadth. In another case the measurements were 1.65 × 1.39 mm. There were very minute dots on the surface of the egg, and from one pole originated a single fine filament. This was of considerable length, being in one case six times the length of the egg, or about 10 mm. In most cases it was shorter, and in some it appeared to have broken off close to the egg. The filaments readily became entangled with each other, so that it was difficult to separate out any particular one without breaking it. At its base the filament had a broad attachment to the outer membrane, of which it is apparently

a modification. At this point it was about $\cdot 04$ mm. in diameter, but soon diminished to about $\cdot 016$ mm. The filament appears to be homogeneous throughout, but, if treated with hot caustic potash, it has the appearance of a thick-walled tube.

At the distal pole of the egg, opposite that from which the filament arises, there is a marked differentiation of the surface of the egg, on a small terminal area about $\cdot 2$ mm. in diameter. This area is covered with clear polygonal markings which vary in size, being large towards the periphery, where they fade off into the surrounding surface. Near the centre they become smaller and less distinct, and



Egg and filament of *Naucrates ductor*.

pass into a small thickened ring, in the centre of which the micropyle may be clearly seen.

There is a large perivitelline space, about a fourth of the diameter of the whole egg in breadth at the middle of the egg. In the specimen figured this breadth was $\cdot 32$ mm.

The egg proper or yolk is an ovoid mass, somewhat more oblong in shape than the outer shell of the egg. It is clear, but granular, and no traces of vesiculations nor oil-globules were seen. In preserved material several cases were observed in which the yolk had shrunk away from its surrounding perivitelline substance, and, in such cases, at the distal end opposite the micropyle, a small funnel-like

projection appeared, which in the normal condition would penetrate the yolk-mass to a slight extent. It doubtless has some function in the mechanism of fertilisation, though no canal connecting it with the microphyle was detected in the perivitelline substance.

The mode of origin of the filament of the egg is different from what is found in some other filamentous eggs of Teleosts. Thus, in the egg of the South African species of *Hemirhamphus* and *Atherina*, I have noticed that, in the immature and even fairly small ovarian eggs, the filaments occur as irregular streaks on the surface of the zona radiata, but, in those of *Naucrates*, the filament is already free, and serves to attach the egg to the wall of the ovary. A number of such filaments are inserted at one spot, so that the ovarian eggs are often grouped in grape-like clusters, or the filaments become twisted on each other to form a rope-like structure, round which the eggs are grouped.

The presence of filaments on fish-eggs, as a rule, has been found to be associated with the fact that they are anchored to each other or to foreign objects, floating or lying at the bottom of the sea. Thus the eggs of *Hemirhamphus*, *Belone*, and *Exocoetus* have been found attached to each other and to sea-weed in this way, though *Scombrosox*, another member of the same family, is said to have pelagic eggs provided with filaments. Another family, the Atherinidæ, all the members of which have eggs provided with filaments, so far as is known, have demersal attached eggs.

There is thus a reasonable presumption that the possession of filaments indicates that the eggs are, ultimately at least, attached to some object fixed or floating in the sea, and, if we suppose that the filamentous eggs of the pilot fish are attached to the shark, with which the fish is so intimately associated, it may explain some peculiarities in its habits which have received a variety of explanations. These are not entirely convincing, partly on account of this variety, but chiefly on account of conflicting facts or of lack of confirmation.

Thus the explanation that the pilot feeds on the fragments of the food of the shark is not in accordance with the fact that small fish have been found in its stomach. The same objection applies to another conjecture that it feeds on the excrements of the shark, and still another that it feeds on the parasites on the skin of the shark. An explanation of a different nature, that the pilot keeps close to the larger fish for the purpose of protection from its enemies, is a more plausible one, but is somewhat strained when its very close

proximity is explained as a precaution against the attack of the shark itself. It is not in accordance with the supposed amicable arrangement whereby the pilot is allowed to have a share of food or excrement, in return for its piloting services. According to actual observation, the shark is not at all disconcerted by the absence of the pilot, but the pilot is said to be greatly agitated by the loss of the shark. It has even been observed "clinging to the side of a shark," and, on one occasion, it is stated that it was seen to leap out of the water in an endeavour to follow a shark which had been caught by hook and was being hauled on board a ship.

Another peculiarity in the behaviour of the fish, which seems to be of some significance in this enquiry, is the well-known fact that it sometimes accompanies large sailing-ships, which it follows so persistently that it is drawn far away from its natural habitat. It even follows the ship into the harbour, where it is easily caught.

Most of these peculiarities would be sufficiently explained if we suppose the pilot's eggs to be attached to the rough skin of the shark, or to the bottom of the ship, which is so persistently followed. We may recall in this connection the solicitude of such fishes as the Bleimies for the safety of their eggs, how they keep close guard over them, driving off any approaching intruder. The close proximity of the pilot to the shark, the darting forward towards any strange object (which seems to be an undoubted fact), the persistence in following the shark or the ship in circumstances which are unfavourable to its own welfare, would seem to indicate a very powerful motive, not dissimilar to that of the fishes which guard their eggs.

The fact that the young stages of *Naucrates* are frequently got, but that no pelagic eggs such as those above described have, so far as I can ascertain, been procured in tow-nets, seems to have some further significance in this enquiry and to indicate that the eggs of *Naucrates* are not floating.

The only sufficient proof of the suggestion here offered would, of course, be the finding of such eggs attached to the body of a large shark or ship, which had been accompanied by a pilot fish, and it may be that, with the above-mentioned facts in view, the opportunity may arise for the solution of the long-standing mystery of the pilot fish.